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# AN ANALYSIS OF THE ACTION CONSCIOUSNESS, BASED ON THE SIMPLE REACTION

THESIS PRESENTED TO THE  
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OF DOCTOR OF PHILOSOPHY

JOSEPH HERSCHEL COFFIN

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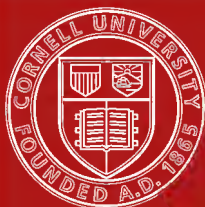
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### INTRODUCTION.<sup>1</sup>

The author began the experiments upon which this paper is based, in the fall of 1904, with the view of ultimately formulating some sort of definition of voluntary action, and of outlining, as accurately as might be, the psychology of it. The impulse which prompted this bit of research seems to have been one in common with a general impulse toward a more complete and satisfactory explanation of the problem which action sets to psychology. For, within the last year (1906), a number of articles and books have appeared,—notably Ach's *Willensthatigkeit und das Denken*, and the *Garmann Festschrift*,—all of which attack the problem of will, and of voluntary action.

Generally speaking, it is safe to say that the phenomena of voluntary action have been, and are, the least understood of any group of psychical phenomena. In the course of the development of psychology, the chapter on 'will' has invariably presented great difficulty to the various psychologists, no matter to what school they may have belonged. It has probably provoked more sheer speculation than any other set of mental phenomena, and also lies at the bottom of a greater number of errors and misconceptions than anything else. Moreover, a great amount of the confusion which has arisen within the science of psychology itself, both with regard to its relation to the other sciences and to philosophy, can doubtless be traced to the different interpretations which have been given to attention, will and voluntary action. Historically, at least, the so-called psychological discussions of will have, in many instances, been purely metaphysical; and where not so, the explanations have led to many and various logical difficulties.

So it is not surprising that Experimental Psychology, with its more advanced methods, and keener insight, should approach the problem of voluntary action, together with other higher, more intimate and more purely psychical processes, with hope and some degree of confidence; and neither is it

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<sup>1</sup> See Appendix F.

surprising that the movement should be a general one. The history of science reveals the fact that advancement has usually been effected by independent, but simultaneous discoveries by different individuals. Hence, in relation to the above-mentioned books and articles, this article may appear to be a timely one.

The Reaction Experiment has had a long and varied life, and has been put to many uses. As a psychological experiment, it was in its infancy from 1820, when Bessel began to investigate the difference in observation times in astronomy, and discovered what he called the 'personal equation,' to 1850, when the need was felt for a more accurate method of observation, and the Registration Method (chronoscope) was introduced. During this period it meant little more than a possible means of standardizing individual differences, in the matter of correct transit observations. In 1856, Mitchell undertook to get the absolute 'personal equation,' by the introduction of the Reaction Experiment proper. He called it the 'personality of the eye,' however, thinking it a defect of that organ. And in this connection, Hartmann discovered in 1858 that expectation and surprise greatly affect the personal equation: in all of which we have the glimmering of its psychological importance.

Thus the Reaction Experiment was finding its way into psychology from astronomy. But 30 years after the personal equation had been discovered Helmholtz (1850) conceived the idea of using the Reaction Experiment to measure the rapidity of neural excitation and transmission; so physiology became interested in it also, at a very early date. It was about this time that Donders worked out his set of experiments on the rapidity of thought, which he believed would be represented by the difference between the reaction time and the physiological time, which he thought he already knew. He therefore combined the physiological and psychological aspects of the experiment and made explicit its psychological value. His classic A, B, and C methods are familiar to every one who is familiar with the Reaction Experiment. And it was upon this as a basis that Wundt began experimenting on the Reaction in 1861.<sup>1</sup>

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<sup>1</sup> For a History of the Reaction, see Sanford, A. J., 2, pp. 1-38.

*Cf.* Titchener, "The Leipzig School," *Mind*, 1892, pp. 206-534; and *Manual of Psychology*, Vol. 2, Pt. II, p. 356 f.

Also note that Titchener paralleled his exposition of action with the Reaction Experiment in his *Primer of Psychology* (1898), and in his *Outlines of Psychology* (1895).



During the 70's there were many reaction experiments performed. Exner (Hermann's Handbuch, Vol. II, Pt. I, pp. 262 ff.) found ten different researches, one of the important ones of which was that carried on in Helmholtz's laboratory by von Kries and Aurbach (Arch. f. Anatomy u., Physiologie, 1877, 297 ff.), the object of which was to find out how sensations are worked up into ideas.

Thus far, then, we have noted four uses to which the Reaction Experiment has been put; (1) in astronomy,—the personal equation; (2) in physiology,—measurement of the rapidity of nerve currents; (3) method of finding rapidity of thought; and (4) a way of studying consciousness. The last two have significance for psychology, and it is plain that Astronomy and Physiology have offered Psychology a most fruitful method for the study of mental processes.

But throughout the history of the Reaction Experiment, as used by psychologists, until comparatively recently, the main interest has always been the temporal measurement of conscious processes. Great tables of reaction times have been made; the effects of practice, fatigue, warning signals, strength of stimulus, etc., were worked out at great length, and their effects on the reaction times noted. Great elaboration in technique was made, but small advance in introspective data, as to the constituents of the action consciousness itself. Introspection was used mainly as a check upon the experiment,—telling the direction and degree of attention, etc.

Without doubt, the most consistent and systematic account of the Reaction Experiment for psychology, historically considered, has been Wundt's treatment of it in the various editions of his *Grundzüge*. Here, as elsewhere, in the early treatment of the experiment, the emphasis is placed on the temporal relation of the ideas, as they run their course; and it is the chronoscopic results as to the actual time duration of the various processes that are of interest to him. A statement of Wundt's position with regard to the Reaction will probably best illustrate the general attitude toward the experiment, as represented in the literature of the 70's and 80's. This attitude would best be gleaned, however, from the first four editions of the *Grundzüge*, for in the fifth edition, his own position is slightly shifted with regard to the matter.

The fourth division of the first edition of the *Grundzüge* (1874), Wundt devotes to a consideration of "Consciousness and the Course of Ideas." The first chapter of this division takes up consciousness and attention. Omitting, for the present discussion, his analysis and characterization of attention as such, and his exposition of perception and apper-

ception, the important point in connection with what is to follow, is, that attention is regarded as the first condition of all clear ideation. The second chapter of this division is entitled, "The Course and Association of Ideas." And here it is that the discussion of the Reaction Experiment occurs. According to this account, then, there are two ways open to the psychologist by which the course of ideas may be studied. One may either seize upon and analyze the course of memory images which constitutes so large a part of our mental life, or one may investigate the changes of ideas dependent upon sensation,—*i. e.*, those that are originated from without. The former of these is the method which has been employed heretofore. But at the basis of this method there lies a fundamental fallacy: *viz.*, it has been supposed that the course of the ideas repeats, without essential change, the temporal course of the original sensations; which supposition need not be true. The second method, then, is the one which must be adopted. And the first task, accordingly, is to investigate the general laws governing the temporal course of ideas as based upon experimental investigation of the relation of their formation and succession, to the original outer stimulus. Now the simplest case of this kind is given when a simple sensation is perceived as a stimulus, in response to which a simple movement is to be made, when the impression has been apperceived: *i. e.*, attended to. To supplement this, it is necessary to have some sort of time measuring apparatus,—some way of determining the time elapsing between the giving of the stimulus and the muscular response which follows. The whole situation is a succession of very simple mental processes, given under uniform conditions, and capable of being investigated. It is a device for the study of the course of ideas; for it is necessary that an idea of the impression shall be formed, that the movement shall be determined upon, and that it be executed. The procedure may, therefore, be factored into the five following steps: (1) The transmission of the nervous impulse toward the centre, (2) the perception of the stimulus, *i. e.*, the entrance of the sensation into the field of consciousness, (3) apperception, or the entrance of the sensation into the focus of attention, (4) the will-impulse, the willing of the action, and (5) the transmission of the nervous excitation toward the periphery. Of these, the first and last are purely physiological, while the second, third and fourth are psychological processes. And of the psychological group, the middle one, apperception, is most important. As a matter of fact, however, the three stand in very close relation, for in the first place, perception may be said to be little more than a pre-

liminary; it is the beginning of what, in its completion is the clear, distinct apperception. This process is not only the most important intrinsically, but also probably consumes more time than the others. In the second place, the will-impulse is more or less automatic in its action,—the movement having already been determined upon. In many cases, to be sure, the will-impulse seems to be a separate act, and to be so recognized in introspection, but in general one has no knowledge of this separateness, but rather feels the two things joined; and the will-impulse seems to be merely a fruition of the potential nature of the apperception. And, in short, we can do no better than to group all five processes together and call the resultant complex, the 'reaction time.' Of this, we have every reason to believe that the greater part is consumed by the psychical, not the physiological part of the process.

Next in the exposition, Wundt gives the norms for the various sense departments, under conditions of constant quality and intensity of stimulus;<sup>1</sup> nothing, however, being said of the various types of reaction, depending upon the direction of attention. Moreover, by making the various stimuli liminal, he finds that the reaction times very markedly approach each other, as to length. He therefore concludes that the apperception time in all cases is the same; and that, where variations occur, they are due to differences in the sense departments that mediate the stimulus. After this, he inquires into the effect of intensity upon the reaction time. Here, he finds that in general, increased intensity shortens the time, in cases where attention has been constant.<sup>2</sup> He also worked with known and unknown stimuli,<sup>3</sup> in which experiments he found that reaction to a known stimulus is of shorter duration than that to an unknown one. Further, he gives results concerning expectation and distracting influences.<sup>4</sup> Entirely unexpected stimuli greatly increase the time, and the presence of disturbing noises likewise lengthens reaction times. In these and other complications mentioned, the thing to be noted is, that the new or changed element has its effect upon the apperception part of the psychical process. Therefore, the thing to be emphasized is, that the nature, and temporal course, of the ideas in that given moment of time are altered. Their kind, number and duration, and their relation to each other in the complex

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<sup>1</sup> Grundzüge (1874), p. 730 ff.

<sup>2</sup> Grundzüge (1874), pp. 733 ff.

<sup>3</sup> Grundzüge (1874), pp. 741 ff.

<sup>4</sup> Grundzüge (1874), pp. 743 ff.

changes with the variations of the conditions. This can be measured in part, at least, by the chronoscope. No other significance seems, then, to be here attached to the Reaction Experiment, than that it is a means of exercising some objective control over the mental processes concerned in a simple flow of ideas, during attention, aroused by a simple external situation. No inkling is here given that the Reaction Experiment furnishes a possible means of studying a cross-section of a simple action,—a use to which it has later been put.

In the second edition (1880) Wundt first uses the term 'simple reaction.' And, following the first edition, the exposition of it is found in the chapter entitled "Apperception and the Course of Ideas,"—the heading of the first paragraph of which is, "Simple Reaction to Sense Impression." The problem is stated here in almost the same words as used in the previous edition; the gist of which is, that it is our task to investigate the course of ideas in a simple case in which a simple train of ideas is aroused by an external impression. And as a method, the simple reaction will serve better than anything else. Here, the reaction is factored as in the previous treatment, and the figures used in regard to the norms of various sense departments are here repeated, no mention being made as yet of the types of reaction.<sup>1</sup> In short, the problems taken up in the two editions are the same, with this exception: in the second edition, he has discovered a further means of studying apperception. It consists in the complication reaction.<sup>2</sup> Here, he introduces the discrimination and choice reaction, and by manipulating the results, is able to obtain temporal values for the interpolated processes. The impression gained from a comparison of the two editions is that, if any difference, Wundt uses the Reaction Experiment more consciously and more systematically to illuminate the course of ideas in the second than in the first edition. On the other hand, he has a deeper interest in the Reaction Experiment for its own sake; he is inclined to develop all its possibilities, as far as he sees them, and to make the systematic application later. But here, as before, the emphasis is entirely upon the course of the ideas during the reaction time.

Again, in the third edition (1887) the discussion of the Simple Reaction occurs in the chapter entitled "Apperception and the Course of Ideas." The problem here, as formerly, is "the investigation of the general laws of the course of

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<sup>1</sup> Grundzüge (1880), pp. 219 ff.

<sup>2</sup> Grundzüge (1880), pp. 247 ff.

ideas, based upon the experimental investigation of the relation of their temporal formation and succession; to which, is added, in the next chapter, a second task: the investigation of the laws of the association of ideas, relying upon introspection of their course freed from outer influences as much as possible." And here again, the simplest case is found in the simple reaction. Then follows the factoring of the reaction just as it was made in the preceding edition.

The main advance which the third edition makes over the first and second, in the matter of the analysis of the simple reaction, lies in the fact that Wundt here accepts and incorporates the results of Lange who had been at work on the factors of expectation and preparation. Lange said that the differences in the reaction times were not to be referred entirely to differences of practice, as had before been assumed, but that there is a qualitative difference in the reaction, yielding two types, depending for their quality upon the direction of attention before and during the reaction. These, he names the 'extreme muscular' and the 'extreme sensorial.' In the first instance, the observer anticipates the motor innervation and attends to the movement he is about to perform; in the second case, the whole strain of attention is thrown toward the expected stimulus. This distinction, Wundt accepts and designates the types the 'muscular' and the 'sensorial.' They are still described, however, with regard to the content of the action consciousness. The one type is explained by assuming that the act of apperception is entirely eliminated, and that perception and will-impulse probably coincide in point of time. The sensorial or complete reaction is one in which all five factors are found, as outlined above (p. 7). In this edition, the reaction is of more intrinsic interest than heretofore; and various complicating factors, such as unexpected stimulus, preparatory signal, distracted attention, the effects of drugs on the observer, etc., find place in the analysis; and false reactions and premature reactions are analyzed. Besides these, the compound reaction is further developed. Choice reactions,—choice between movement and rest, between two or more movements,—discrimination reactions and association reactions are all developed and analyzed. While the systematic place of all these things is to be found in relation to the course of ideas during the period of reaction. They are all made to illuminate the phenomena of conscious processes which have their existence during the moment of time under consideration.

In the fourth edition (1893) the treatment of the simple reaction is the same as in the third, whereas the compound

reaction receives more attention. The association reaction is further developed, likewise the discrimination; while at the close a few paragraphs are devoted to the subjects of the tendency toward automatic co-ordination, and reflex movement in the reaction, and their effects upon it. But as regards the attitude toward the reaction, there is no change. The value of the experiment lies in the fact that it furnishes a means of studying the ideational content of mind during a given measured period of time.

Before considering the exposition of the Reaction Experiment as set forth in the fifth edition of the *Grundzüge*, it is necessary to notice a new tendency in the way of considering the reaction. From what has preceded, it is plain that the Reaction Experiment was made use of, up to this time, for any one of four things: (1) to obtain reaction norms for their own sake, (2) as an experimental control for determining the temporal course of ideas. It was assumed that, since it takes time to make a reaction, there must be some conscious content during that time, which conscious content could be described as ideas. The reaction then, furnished a means for factoring,—and measuring the factors,—the conscious processes contained within the limits of the reaction. The assumption upon which this use of the Reaction Experiment was based seems to be logical, to about the same degree that it is psychological. (3) A large list of experiments upon the determination of practice, fatigue, and various conditioning factors of the reaction, following naturally from (2). (4) A large number of experiments with the view of determining the various types of reaction.

In addition to this, the experiment was made use of quite extensively during the 90's with the view of determining by its aid, mental types; and also as a differential test in abnormal psychology and artificial derangements. But little use seems to have been made of Külpe's suggestion that the reaction is a simple voluntary action, and that the latter is, therefore, accessible to scientific investigation. Indeed, the investigation seems to have received such impetus in the direction already remarked, that it is only within the very immediate past that the action consciousness has thus been attacked by means of the reaction.

In 1893, the same year of the fourth edition, Külpe made the following statement: "the reaction is an action in response to a peripheral stimulus; and thus, action is accessible to scientific investigation." Looking at it from our present vantage point, it seems strange that it had not been considered in this light before. But the reason is doubtless to be found in the fact that the interest which the reaction

brought with it from astronomy, and, later, from physiology, were entirely foreign to the present psychological interest. The original impetus was in the direction of the temporal measurement of mental and physiological processes, and, naturally, the investigation followed the direction already marked out. It is difficult to evaluate the net result of the great amount of experimentation which was carried on along this line:—certainly it was great. But the fact remains that it was as the extreme swing of the pendulum; the reaction experiment was carried past the point where it could do the most good for psychology. Stress was laid upon what now seems to us to be secondary considerations. But the reaction experiment was eventually to find its rightful place; and it was doubtless Külpe's statement that formed the turning point at which the new beginning should be made. The new attitude is also reflected in Wundt, for, as was intimated above (p. 5), he shifted his position in a measure to conform to it.

Accordingly, in the fifth edition (1903) of his *Grundzüge*, Wundt brings the chapter containing the exposition of the reaction, in after the chapter on Will, and makes many references back and forth. The chapter containing the discussion of the reaction, is entitled "Consciousness and the Course of Ideas," and is treated in the same connection as in the earlier editions. There is, however, this very noteworthy change of attitude; the reaction, which has heretofore been used to determine the temporal course of ideas, *really involves an act of will*; "the reaction process is a *will* process, which is set up by an outer stimulus, in order to terminate in a movement spontaneously following the apperception of the stimulus, which movement is the reaction movement." "The reaction experiment permits the analysis of the conscious processes during action, at the same time recording the objective time between the stimulus and the movement." And again, "the reaction is the typical form of the will process:—here we can analyze will and its various processes." These statements and others point conclusively to the new attitude: that the reaction has come to mean more than the temporal measurement of a set of mental processes which follow each other in point of time. It has come to be a matter of studying a simple voluntary action.

In regard to the analysis of the simple reaction, the following may be noted: It is here factored as in the preceding editions, with the exception that the first and fifth events—physiological—are divided yet further. The first may be supposed to consist of (i) the stirring up of the sense organ,



and (ii) the conduction of the nerve current to the appropriate nerve centre. The fifth consists of (i) the conduction of the peripheral excitation from the appropriate centre, and (ii) the excitation of the muscle. The processes (2), perception, and (3) apperception, and (4) will impulse, may overlap each other, or some of them may coincide, or be lacking (*cf.* above). The simple reaction, as an action, may thus be further analyzed. The simplest case of responding to an outer stimulus is to be found when we await a given sensation which is to be raised to an idea, and without the interpolation of other processes, to make a simple pre-determined movement upon its apprehension. It contains, as psychical processes, the following things: the perception of the stimulus, entrance into consciousness, the apperception, or entering into the focus of attention, and the formation of the will-impulse. A sensation, by virtue of being a sensation, lies in the field of consciousness and accompanies the stirring up of the central mental tract, and is, therefore, a psychophysical event. An especial activity, which we perceive subjectively, is necessary in order to direct the attention to such a sensation. But this may also be a psychophysical event, for there is probably a nervous change corresponding to it. Finally, the will impulse, which closely follows apperception, is in the apperception of the out-going movement. In the simple reaction, this consists of the impulsive apprehension immediately following the apprehension of the stimulus which takes place at the same time that the excitation of the central motor tract is supposed to occur. Therefore, the will impulse may also be considered to be psychophysical.

Notwithstanding the fact that Wundt, in his last edition, feels the force of the argument in favor of regarding the reaction as the type of all voluntary action in general, it is noteworthy that he still treats it as a way of studying the course of ideas, the course of ideas during *action*. But he gives us nothing particularly new with regard to the psychological facts; merely a new attitude toward the facts. On the other hand, Külpe, at the time that he made the statement that the reaction is a simple voluntary action in response to a stimulus, says, "the duration of the reaction is dependent upon external and internal conditions. . . . The changes which are due to the internal conditions are of greater psychological importance (than the external). Besides altering the duration of the whole act, they usually imply a qualitative modification of its contents. Especially important in this connection, is the *preparation* of the subject for the reaction." (Outlines, p. 407.) And again: "The

essential dependence of the whole process upon the intensity of the preparation, is shown by the marked influence of the time allowed for the concentration of the attention upon the rapidity of the reaction." Now this preparation lies in the conscious state of expectation. There is an apperceived idea either of the impression, in which case we have the sensorial reaction, or of the movement to be made, in which case we have the muscular type. This apperceived idea, using Wundt's terminology, is accompanied by, and is fused with, the muscular adjustments that are characteristic of the corresponding type. Hence, when the impression comes, the movement goes off. In the ordinary way of conducting the reaction experiment, then, the period between the signal and the stimulus,—the time of preparation,—is, for Külpe, the most important one. For the nature of the preparation determines the quality and nature of the reaction. Here, then, is something entirely new; while holding that the reaction is a type of voluntary action in general, Külpe goes a step further and says that the mental antecedents of the reaction—the preparation—are the most important thing. While in sharp contrast to this attitude, and in correspondence to his previous conception of it, is Wundt's way of regarding the reaction. While recognizing that the direction which attention takes is largely responsible for the nature of the reaction, it is the actual content of consciousness at the time of the reaction itself to which he attaches importance. This content is the so-called perception, apperception, and will impulse; and it is this in which he is interested. To make the contrast more explicit, Külpe regards the time of preparation for the action,—from the 'now' to the stimulus,—as the most important, while Wundt still clings to the notion that the conscious content from the stimulus to the movement is the important part. This, then, shall be one part of the problem set before us in this paper, which we shall endeavor to answer. We shall try to determine from a great mass of introspective data obtained from the simple reaction, which of these two periods in the process of action is of greatest psychological importance.

In approaching the action consciousness by way of the simple reaction, it may be well to get clearly in mind the reasons why the reaction may be used in this way. Külpe says (*Outlines*, p. 407), "the reaction is simply the exact type of all actions, as they are termed in the psychology of everyday life, which are initiated by an external stimulus. . . . It is not difficult (p. 409) to discover analogies between the forms of the simple reaction and certain activities or actions in everyday life. Every one must have had ex-

periences which recall the premature or erroneous reaction; and every one knows the difference between two actions, one of which is continuously directed by the idea of end, while the other is accomplished step by step, as it were, each stage in its execution requiring special preparation. When the series of factors involved in an action has become familiar by long practice, there can be no doubt of the advantage of a constant idea of its ultimate end." Now why can we say that "the reaction is the exact type of all action?" If we may define action provisionally and in general terms, as consciously conditioned movement, *i. e.*, movement which has motive, conscious antecedents and concomitant kinæsthetic sensations—movement with a psychophysical set, it is plain that the simple reaction may justly be termed an action, because it fulfills the conditions:—provided the reaction is taken before it has had time to become automatized, or in Wundt's terms, a cerebral reflex. The simple reaction undoubtedly has conscious antecedents of the most definite kind. If there are to be conscious antecedents, the mind must be in a state of attention, and this we have to a very great degree in the case of preparation. The attentive state and all it signifies *is* the conscious antecedent of the reaction, and this conscious preparation is certainly as distinctly present in the reaction as it is in ordinary life. Following Wundt, nothing could be more conscious than the perception, apperception and will impulse found in the action. If there is any difference in the conscious conditions of the reaction and ordinary action, the former is more distinctly conscious than the latter. In regard to the consequences in the two cases, the affective tone, which constitutes the bulk of the after effects, may be, and probably is, in the reaction more indifferent than in most ordinary actions. But this is due rather to the simplicity of the reaction, than to any qualitative difference as to the nature of the two things. Again, since the reaction is a movement in response to a stimulus, which definition implies consciousness as a condition, it becomes evident that it is at least a *case* of action whether it is the type of action or not, from the very definition. But, so far from being merely a case of action, it seems that the reaction is also the type of action, for several reasons. First, it is undeniable that all action, properly speaking, implies bodily movement of some sort, and that the movement follows upon stimulation of some sort,—using 'stimulation' in its broadest sense to mean both inducement and incentive, implying both external and internal excitation. Now the reaction seems to be the simplest case in which these various factors are found, nevertheless, it seems to

contain all the essentials of voluntary action. To be sure, the movement in voluntary action may be ever so complex, *e. g.*, the movements involved in writing, but it is still movement in response to some stimulus. Likewise, the stimulus, so far from being merely one simple expected sensation, may come from any part of our varied conscious experience, —a sensation or sensation complex or a benevolent impulse, but it is still a stimulus. In other words, the reaction is voluntary action reduced to its lowest terms. It is voluntary action with as many of the complicating factors ruled out, as it is possible to obtain it. Attention is narrowed down, and directed to some one expected impression, or some movement pertinent to the reaction experiment, instead of being busied with the larger affairs of professional life, in which case, every particular stimulus has to be attended to after it comes, and the appropriate movement both selected and executed afterward. Moreover, in most ordinary action, there is nothing that corresponds to the 'ready' signal of the reaction. The stimulus simply breaks in upon consciousness unheralded, and attention has afterward to be adjusted, or preparation for the movement has to be effected after the stimulus has been received, instead of before. And more than that, instead of there being one particular movement or set of movements, ready prepared for, so that they go off as soon as the stimulus has been apperceived, the *right* movement must be executed. But everywhere and always, action is consciously conditioned movement in response to some stimulus; hence, in all fairness it may be said that the reaction represents voluntary action in its simplest terms. With regard to that which we ordinarily term volitional action, which term indicates the more subjective nature of the stimulus, we have merely to widen the meaning of the term 'stimulus' in order to make it include those more subjective promptings which characterize those acts. Thus defined, action is still consciously conditioned; the stimulus is still a conscious affair, indeed more intimately conscious, if any difference, than the more objective stimulus, the sensation, and movement results as a consequence.

If, then, the action consciousness may thus be considered as a type of voluntary action, it follows that a thorough analysis of the reaction will of necessity throw some light upon voluntary action in general. If by an introspective analysis of the simple reaction, we are able to determine what the actual constituent processes are, and which of them is of most importance we shall have added something to the sum-total of the psychological knowledge concerning voluntary action.

And it is with this that Part I has to deal.

## PART I

### THE ANALYSIS OF THE SIMPLE REACTION

The following analysis is based upon the introspective results from a set of reactions of the auditory type. It would have been interesting as well as valuable to have had an equal amount of introspective data from experiments from other sense departments. But such would have required more time than was at the disposal of the author; and, besides, it may be assumed that what is essential of action in response to an auditory stimulus, would likewise be essential to a simple reaction to a stimulus from any other sense organ.

Five observers were used. Miss Murray (M) was Scholar in the Department of Psychology, and had had three years of psychological work. She had done the reaction experiment as outlined in Titchener's *Manual of Psychology*, three years before, so had had some practice in introspective work of this kind. Miss Peirson (P) was a junior in Cornell and was in her second year of psychological work. Mrs. Pattison (Pn) had had about the same amount of psychological training as Miss Pierson. Both ladies had done the reaction experiment before, in the drill course in Cornell. Mr. Foster (F) was doing his second year of graduate work. He was a thoroughly conscientious student with some psychological training, but had never done the reaction experiment. To Mrs. Coffin (C), the reaction was entirely new, as she had had no introspective training.

As the recording instrument, the vernier chronoscope was used. This instrument was chosen for three reasons, in preference to the Hipp chronoscope, which was at hand, and might have been used. First, great accuracy was not demanded. The times were used merely as a check upon the introspections, the great weight being thrown upon the latter; second, the experimenter wished to be near the observer, that he might observe him; and third, the experimenter wished to be able to question the observer as occasion arose.<sup>1</sup>

The order of the experiment was as follows: A 'ready' was given, at which the observer closed his eyes and laid the index finger of the right hand on the key of the short pendulum. After two seconds, the experimenter said "now," and in two more seconds tapped the key of the long pendulum, which was the signal for reacting. Fifty 'Natural' reactions were taken from each observer, and approximately 200 'Muscular' and 'Sensorial' reactions respectively.

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<sup>1</sup> See Appendix A.

The instructions for the Natural Reaction were as follows: "At the 'ready' you are to place the finger upon the key, close your eyes, and assume a comfortable bodily position. At the 'now,' prepare for reacting by concentrating your attention; and upon hearing the stimulus, push the finger down. Then, with eyes still closed, and bodily position unchanged, you are to recall the experiment as vividly as possible and immediately afterward, write out a full account of it." Since time was taken for the observer to write out his introspections, ten reactions per day were as many as could profitably be taken, as more would have been fatiguing.

The Natural Reaction which was taken up first, served mainly as a preliminary to those which followed. Not a great deal of value, introspectively, was obtained from them. To some of the observers, the reaction was entirely new, while the others were more or less rusty in that sort of introspection, hence the main value of it was to accustom the observers to the method, and to teach them the kind of observation that was required. In addition, the novelty of the experiment was allowed to wear away, and the main features were allowed to become evident.

It might seem that the very fact of practice would alter the conditions and thereby change the content of consciousness; that introspection would accordingly be changed, and steps fundamentally important to the natural reaction be dropped out. This may be true, and probably is to some extent, but the loss is partially recompensed by the added facility in introspection, and the standardizing of the conditions which gives opportunity for more than a single view of the reaction.

The photograph of the action consciousness is best taken just after the experiment. One can then put oneself through it again just as it was experienced. The various elements and processes can be enumerated, dwelt upon, compared and fixed in memory till they can be written down. The stability of introspection depends upon practice sufficient to rid one of the feeling of novelty, to make one at home with the experiment, and to enable the important and elemental processes to sift themselves out and assume bold relief in the whole picture. But it is also true that habits in the way of reaction very soon form; and introspection cannot be of much value after the experiment has become stereotyped. And sooner or later, in spite of the experimenter's instructions, and the good intentions on the part of the observer, the experiment is bound to traverse the same paths after a certain number of repetitions.

### A. THE NATURAL REACTION.<sup>1</sup>

In the natural reaction, the attention upon which the whole nature of the reaction depends, is at first distributed over the whole experiment in a confused sort of way. No determined mode of procedure or system has yet been established. Now one thing, now another claims the attention; the stimulus, the movement to be made, an anxiety to perform the experiment satisfactorily, strain sensations, images, feelings of unreadiness, and many other things get their share. In a word, complex feelings, and higher mental processes mingle with simpler and more elemental ones to form a general chaotic state. The events from the 'now' to the reception of the stimulus constitute a new experience, and there is no predetermined way of getting ready for, or receiving the stimulus as is the case after practice. Each experiment stands apart from all others and is of its own peculiar kind, having its own peculiar contents and conditions. There can be nothing particularly predicted of them as a class, except that their nature depends upon the mood of the observer as he goes into the experiment. If he has a feeling that the preceding experiment was not carried out to the satisfaction of the experimenter, as to introspective results, reaction times, etc.; if he has not gained the upper hand of the experiment, and other similar misgivings, the contents and conditions of consciousness during reaction are very different from what they are when the opposite mood prevails. It is also obvious that reaction times under such varying conditions vary greatly in length; as a matter of fact, from about 14 to 40 sigma.

Each of the conditions mentioned under this heading will come out in more detail in the description of the muscular and sensorial reactions. The reception of the stimulus, the action and the after-effects can also be better treated in the light of clearer introspection and more constant conditions which necessarily follow practice.

### B. THE MUSCULAR REACTION.<sup>2</sup>

In all but one of the observers (P), the natural reaction passed over into the muscular type after about 40 trials, and it became habitual, of course, to attend to the movement to be made. In this, the conditions are more easily described, but the contents of consciousness are more difficult to determine, because the reaction time is much shorter

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<sup>1</sup> See Appendix B.

<sup>2</sup> See Appendix C.



than in the sensorial. In the case where the observer was of the sensorial type, the same number of experiments were sufficient to establish that mode of reaction; and the times, though longer than the muscular, became much more regular than they were at first.

The instructions for the muscular reaction were as follows: "Attend to the movement you are going to make. Prepare yourself *for* the movement, so you may be on the alert to move upon hearing the sound of the stimulus. The sense impression will give you the opportunity to make the movement you have been waiting for since the 'now'." It is interesting to notice in this connection that the very nature of the reaction experiment seems to suggest to the observer that the important thing is the *reaction time*. Even when the precaution has been given to disregard the time element, and simply to 'react upon hearing the stimulus,' there is still the desire to do it quickly. And when the observer has been plainly told that the important part is a careful introspection the same desire still persists. The tendency is especially noticeable in observers whose natural way of reacting is muscular when they are required to perform the sensorial reaction. They feel that attending to the stimulus is incompatible with a 'good reaction.' For with these the 'good reaction' comes to mean a *short* reaction time.

In order to get a complete photograph of the reaction, the muscular and sensorial reactions were divided into four parts: (1) from the 'now' to the stimulus, (2) the reception of the stimulus, (3) the movement, and (4) the after-effects.<sup>1</sup> The whole series of muscular and sensorial reactions, accordingly, were divided into four sets of fifty experiments each, respectively. The observer was asked to throw the introspective attention in turn upon the four periods mentioned. First, he was told to react muscularly, in conformity to the instructions given above, and during the first fifty experiments, to analyze the period of preparation, *i. e.*, from the 'now' to the stimulus; during the next fifty experiments, the introspective attention was directed to (2) the reception of the stimulus; and so on throughout the four periods. In this way, it was thought, a more minute, intensive analysis

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<sup>1</sup> Ach, in the book already referred to, factored the reaction much after this manner. He used three periods, however, instead of four: period of (1) preparation, (2) movement, (3) after effects.

Titchener also suggested this method. *Cf.* Manual, Vol. II, Pt. II.

could be effected than would be obtained by an equal number of general muscular reactions. This same intensive method of introspection was employed with the sensorial reaction, the difference being one of instruction rather than introspective method.

### I. PREPARATION: 'NOW' TO THE STIMULUS

The time from the 'now' to the stimulus, or the time of preparation, seems to be of most importance and yields the greatest amount of introspective data. The processes then at work give it its mark of distinction, and its peculiarity. Beginning with the 'ready,' there is a pulling together of oneself and a narrowing of attention to the business in hand:—a voluntary shutting out of distracting noises and thoughts. With the 'now,' preparation proper begins. There is a tensing of the muscles of arm, shoulder and hand. The observer leans forward, inclines the head, and makes the finger the focal point of attention. Analysis shows that all this is constituted of a countless number of strains in all parts of the body, especially about the arm, finger and eyes. Images also play back and forth during the interval; images of apparatus, the observer's own person, kinæsthetic images in the finger, of the movement to be made.<sup>1</sup> And these strains, images, etc., vary with the degree of attention. In short, the observer puts himself in a special psychophysical attitude. It consists of a predisposition to make a certain movement, a summation of energy, and a cessation of everything else in order to be ready for the cue to let go. One observer describes the kinæsthetic sensations arising from it as a strange tingling in the finger. So perfect does this attitude become that the attention during the first part of the interval may be conceived in popular terms, as organizing the reflex, then leaving it and engaging itself with the coming stimulus. This waiting for the stimulus is often felt as a bare passage of time, the content of which is doubtless to be explained in terms of organic sensations, compressed feeling about the heart and lungs if the breathing is in any way interfered with,—together with other sensations.<sup>2</sup> An

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<sup>1</sup> The point with regard to the kinæsthetic images is a disputed one, many claiming that the so-called images are in reality weak sensations. But as far as my data bear upon it, the evidence is in favor of such images. Cf. Külpe, Outlines, and James Psych.

<sup>2</sup> Cf. article in Meumann's Archive on Descriptive Psychology, in which the author says the feeling of the passage

interesting side light upon this attitude is the fact that the effort is felt as being negative, instead of positive, during the last part of the interval. That is, the observer feels that he must hold back, or inhibit the tendency to react, until the signal comes. To forget this is to react too soon.<sup>1</sup>

## II. THE RECEPTION OF THE STIMULUS

The stimulus comes as a signal to let go, as a cue for the releasing of the movement. There is no feeling of surprise or strangeness, as may be the case in the first few series of the natural reaction. It is simply expected as a part of the natural order of events. Moreover, any noise which occurs at the time of the expected stimulus is accepted as the proper signal. Sometimes the observer is not conscious of having reacted to the wrong stimulus, and when he does become aware of it, it is usually because of the sight of the single swinging pendulum, or the different tactual feeling of the false stimulus. The ordinary stimulus carries with it a certain jar and vibration which is lacking in others, and the lack of this makes the stimulus feel different, and so forces itself into consciousness. But when the experimenter takes the precaution, silently to set his pendulum swinging, simultaneously with the false stimulus, the observer does not realize his error nearly so easily. This holds true when the false stimulus is somewhat similar to the real one, as the sound made by tapping the table instead of the reaction key. Perfectly absurd noises, however, such as the snapping of the finger, are often sufficient to set the movement off, but are recognized afterwards as being false. Sometimes the sound of the stimulus hardly enters consciousness at all. In such cases, that which does seem to be the conscious factor is the jar, cutaneous sensations set up by the mechanical vibrations occasioned by the striking.

It is interesting in this connection to note the effect of the content feeling of the interval, mentioned above. If a false stimulus is given before the two-second interval is over, there is little tendency to react to it, showing that the observer has to have the 'ready' feeling before he can give himself up to the reaction; also that he has learned from

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of time is the activity of a pure thought element, because there is nothing else there.

But so far as the evidence gathered in these reactions goes, the passage of time seems to be a perception of a succession of organic sensations.

*Cf. also, Titchener, Manual, Vol. II, Pt. II, pp. 395 ff.*

experience to be ready at the end of the two-second interval, so that if the stimulus comes too soon, his attention is called to it, he recognizes it as false, and hence does not react. Moreover, if the interval be shortened and the right stimulus is given, the reaction time is lengthened and the experiment seems less satisfactory to the observer than when carried out in the regular time relations. In other words, instead of the mere sound of the hammer on the key, the real stimulus comes to be sound-of-hammer-plus-content-of-consciousness-after-'now.' When the interval is kept constant (objectively) the reaction times will be most regular, and the observer feels the experiment to be most satisfactory. If the intervals are shortened or lengthened, the reaction ceases to be purely motor, and attention is directed more or less to the stimulus.

### III. THE MOVEMENT

The reception of the stimulus, *i. e.*, the cue for the release of the movement and the release itself, or the movement, are very closely connected both in consciousness and in time. It is therefore difficult to discuss them separately. The movement, in the purely muscular type, goes off with a jerk when the stimulus is heard. The predisposition has already been prepared, and as soon as the signal comes, the release is made,—the restraint is taken away, and the movement has been brought about. As for there being conscious concomitants of the movement, introspection does not reveal any. The nearest it approaches it, is in the recording of the kinæsthetic sensations set up by the movement itself. In cases where the observer pushes the key before the stimulus has been given, there may be either one of two causes assigned: either the tension in the finger is so great that the finger has simply and accidentally borne too heavily upon the key, thus letting the pendulum swing unknown to the observer, which of course, is not a true reaction; or the interval measured by the content of consciousness has been longer than usual (subjectively) and the reaction takes place in response to this as a stimulus. And in so far as the content forms a part of the stimulus, the reaction was a proper one, only premature. If the objective stimulus coincides nearly enough with the subjective part, the reaction times are short, as counted by the pendulum swings (.04, .06, .08, etc.). In which cases, it merely accidentally assumes the appearance of the normal reaction. But in reality should not be so counted. Where the real interval seems subjectively to have been shortened, the reaction time is lengthened.

In some cases, the reception of the stimulus and the reac-

tion seem to the observer to be simultaneous. He feels no sequence in them. But when he does recognize the stimulus to be followed by the action, one would expect the longer times to yield a greater amount of introspective material. But this is not the case. Where there is a difference of as much as .08 or .10 of a second there is no appreciable difference in introspection. Consciousness seems to be suspended while the neuro-muscular apparatus gets into action.

While there seems to be no simple process which can be named and described during this time, there is often, in the longer reactions a complex hesitancy; a feeling that "I am not reacting as promptly as I could." What this feeling is, or why they experience it, the observers cannot tell. One is inclined to think in this case that attention has become a sort of ideal spectator which stands off and looks on at the predisposition, the movement, and the stimulus. And in thus doing, disables it to a slight extent.

#### IV. THE AFTER EFFECTS

The after effects of the reaction are complex. In the first place, it is a letting go, and easing down of attention, consciousness again widens out, and new trains of thought are started. In most of its aspects, it seems to be the reverse of the preparation period. Where there, the observer assumed a certain bodily attitude, closed his eyes, and narrowed down his attention,—in short assumed a certain psychophysical predisposition, we here find him relaxing the body, opening eyes, and completely getting out of the reaction attitude. In the second place,—and more important,—the affective tone of the experiment is made manifest here. As a general rule, there is not very much affective tone attaching to the reaction experiment; and especially is this the case after much repetition. But where there is, it is shown in pleasantness caused by a consciousness of having performed the experiment satisfactorily or some such general feeling. The pleasantness is occasioned by the whole of the complex situation rather than by any one definite sense impression or idea, and is in consequence, correspondingly vague and of little intensity. On the other hand, unpleasantness is usually occasioned by some definite strain sensation, or idea. It is after the experiment is over that one realizes that there has been discomfort, or uneasiness, or unpleasant strain. Under normal conditions, the experiment is more often of a general satisfied feeling (pleasant) than with unpleasantness.

### C. THE SENSORIAL REACTION<sup>1</sup>

The chief difference to be found between this sort of reaction and the muscular is mainly in the first stage, viz., the preparation. The instructions given to the observer are: "You are to pay attention to, and watch for the stimulus. Do not bother with the movement, for it will execute itself when the time comes. You must find some way of recognizing the stimulus as the right one immediately, *e. g.*, have an auditory, visual or motor image by which to recognize it. You must be sure to have clearly recognized it, so that you will not react to a wrong stimulus. And this must be done directly, so that you shall not make a discrimination reaction of it, by stopping to *decide* whether it is the right sound or not. Simply be able to know it, and to know it immediately."<sup>2</sup>

The great difficulty in this set of experiments was, that these observers, with one exception, found it very difficult to follow the instructions. It required considerable practice for them to be able to put themselves into the right attitude. An attitude too aggressive and too active is as fatal to the experiment as the other extreme would be.

In addition to the above, it should also be noted that the observers had been made acquainted with the nature of the discrimination reaction. It was deemed necessary that they should know, in order to forestall any tendency toward the discrimination reaction.

#### I. PREPARATION

In this, as in the muscular reaction, the important period, and the one yielding the greatest amount of introspective material, is the period of preparation. And this is a fact of great significance. Despite the fact that the second period (from the stimulus to the movement) is much longer in this than in the muscular reaction, and, therefore, would seem on the face of it to contain more, and to be of more importance in the simple sensorial reaction, nevertheless, here, as before, the time of preparation is of most importance. It is very possible, and indeed probable, that in the choice or discrimination reaction, and those of like nature, the second period would be of the most importance, for in them the essential and characteristic processes do take place in this period.

But here, as in the muscular reaction, beginning with the 'now,' there are the numerous strain sensations and tensing

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<sup>1</sup> See Appendix D.

<sup>2</sup> Titchener: Manual of Psychology, Vol. I, Pt. II.

of muscles which go with active attention. They are largely transferred, however, from the finger and hand to the eye and ear, head and neck, indicating a different direction of attention. In short, the attitude is one of listening; the hand drops out of consciousness and attention turns to the expected stimulus, instead of making the finger the focal point. This is done differently by different observers, depending upon their type. A visually minded person gets a visual image of the hammer descending upon the key, others have auditory images, and others tactual<sup>1</sup> and muscular. As a matter of fact, however, it is usually a mixture or combination of these types. In the sensorial as in the muscular, the observer develops sort of a predetermination toward the end in view, as the preparation progresses. It is not so nearly altogether a muscular affair this time, however, for he holds before himself a mental pattern or image, by which to identify the stimulus when it comes. The muscular predisposition and the mental image play into each other's hands in the process of the experiment. The business of attention is to create and hold this image in a way most easily to identify the stimulus, if it be a correct one, or to reject it if it be false. If the incoming stimulus fits the pattern the movement goes off; if not, there is no tendency to move, and the pressure is let down. In the muscular type, we said, "the stimulus is the cue which is the signal to let go." In this type, the signal is not merely the stimulus but a stimulus-of-the-right-pattern. Anything else is not a stimulus. Hence, in order to be a stimulus, the sound must fit the pattern held in attention.

It need hardly be said in this connection that this kind of reaction is difficult for muscularly minded people to make in its pure form. The difficulty is, either to keep control of the muscular predisposition so as not to make a muscular reaction or to avoid the other extreme of waiting to think about and judge as to the stimulus, either of which cases throws the experiment out. It is interesting to note that when a false stimulus has been given, and the observer has kept his attention maximal, there is a summation of energy which needs letting down; and this is accomplished by some characteristic movement,—as by the jerk of the head or the shrug of the shoulders.

## II. RECEPTION

It has already been said that in order for a sound to be a stimulus it must fit the pattern which the attention actively

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<sup>1</sup> Cf. note on page 34.



holds. When the attention is maximal, *i. e.*, when the pattern is clear and distinct, the stimulus is apprehended as right or wrong; it either fits, or it does n't fit, and this immediately. If it does fit, it is accepted as the cue for the release of the movement. The interval between the stimulus and the movement is much longer in the sensorial reaction than in the muscular, and varies more. The time is occupied with the apprehension of the stimulus, *i. e.*, the stimulus is applied to the pattern as it were, and the identification made. When the attention is partially distracted, the pattern loses its distinctness, and becomes hazy, and if the stimulus comes at this time it cannot be recognized as easily and directly. In other words, the image has again to be called up and a judgment made. When the attention is constant throughout a series, the reaction times vary but slightly. There seem to be all grades between pure sensorial and choice reactions, but all depends upon the attention and vary with it. Hence, after the observer has learned to apprehend the stimulus immediately, and when in condition to keep the attention constant, the experiments become very much alike and reaction times are constant.

When the instructions have been for the sensorial reaction but the observer reacts to a wrong stimulus, either one of two things happens. Either the attention has wandered, and the reaction has been a purely muscular one, or the muscular predisposition has been so strongly organized that the subject may release the pendulum when the attention is maximal, even while perceiving the stimulus to be false, and having no inclination to press the key. In this case, the movement has been unconscious to the observer, and is not a reaction in the true sense.

When the objective time interval between the 'now' and the stimulus is lengthened or shortened, the result is the distraction of attention, and in either case, the lengthening of the reaction time. There is not such a content feeling in this as in the muscular reaction, but there is a gradual heightening of the attention wave, during the preparation stage, and if the stimulus coincides with the crest of this wave, in point of time, the recognition is more easily made, and the reaction time shortened.

### III. THE ACTION

Once the stimulus has been recognized, the movement is released, or better, goes off. The muscles have already been prepared for the movement, the muscular predisposition already effected, as in the muscular type of reaction,—except that the tension in this is not so great. The organization

has been mainly unconscious, however. Hence, as soon as the signal is recognized, the movement takes place. Introspection does not tell us what the step or process between the recognition of the stimulus and the movement in the sensorial reaction, any more than it did in the muscular. Introspection reveals nothing aside from certain kinæsthetic sensations which are set up by the movement itself, as in the former case. The movement is more deliberate in this case than in the case of the muscular reaction, however. In the latter, the movement went off with a sort of jerk involving the whole arm, while in the former, it is an orderly, fully controlled and deliberate movement. The reason for this is doubtless to be found in the character of the muscular set in each case. In the muscular reaction, the tension is high and the strain great, hence the movement, when released, goes off with a jerk; while in the sensorial, the set is not so tense nor the strain so great, hence the movement is made less rapidly.

The observer almost always has a feeling as to the quickness of the reaction.<sup>1</sup> But he is not able to judge with any accuracy as to the length of the reaction time. In exceptionally long reactions he may report the time shorter than in others, which in reality were shorter. This again can be referred to the state of the attention, at least for a partial explanation. When the degree of attention is maximal, the reactions are objectively shortest, but they may feel longer to the observer than others where attention has evidently waned, probably for the same reason that a given length of time seems longer or shorter under differing conditions, *e. g.*, suspense or composure.

#### IV. THE AFTER EFFECTS

The after effects are much the same in this as in the muscular reaction, with this difference. There is not felt to be so great a letting down of muscular tension, for the reason that there is not so much muscular strain to begin with. Moreover, this sort of reaction is a greater tax on the attention, and there is, consequently, a greater widening out of this, at the end, than is the case in the muscular. In like manner, whatever affective tone attaches to the experiment makes itself felt in this stage.

#### CONCLUSIONS FROM THE ANALYSIS

With regard to these results, it may be noted first, that of

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<sup>1</sup> See Watanby, A. J., VI, pp. 408 ff.

the four parts into which the muscular and sensorial reactions were divided, the first seems to afford the best opportunity for analysis. It is easier for the observer to introspect this period than the others; and as a consequence, the greatest amount of introspective data comes from it. In other words, there are more events that may be singled out, remembered and recorded here, than at any other time during the reaction. The fact that there is a greater number of events in this period does not necessarily mean that for that reason, the period is of the most importance, of course. It does not mean that it is any more essential for that reason alone. But on the other hand, the essential processes then at work, are of very great intrinsic value. Indeed they are essential factors of the reaction. If it were possible to have an action without conscious antecedents, *i. e.*, without some degree of attention, then there would be no ground for claiming that the processes of the preparatory stage are essential. But since the very concept 'action' implies a certain degree of consciousness and therefore, of attention, it is inconceivable that the action should take place without the initial process of directing the attention to the business in hand. We saw by the analysis that everything belonging to the first period was subservient to the one process of appropriately directing the attention. All recorded bodily strains were merely so many concomitants of the directing of attention, and the place at which they were localized only branded the attention as being one type or another. So that if there is any truth in our conception of action, as implying at least some degree of attention, it seems that Külpe was right in insisting upon the importance of the preparatory stage in the reaction. Not only so, but the further fact that the degree, and direction of attention in this stage determines the nature and rapidity of the reaction, also adds weight to the assumption.

With regard to Wundt's content theory. Our analysis fails to evince anything like so complex a process in consciousness, as would be implied by his perception-apperception-will analysis. In the muscular type, no conscious processes corresponding to each of these three things were recorded. What is actually there,—what observers are able to remember and write down, is nothing than the simple perception of the stimulus, after which nothing more is known about the reaction process, until kinæsthetic sensations come in telling of the actual movement that is taking, and has taken place. Wundt's theory seems to rest upon the assumption that no idea can be acted upon until it has come to the focus of attention, and that it cannot arrive at the focus of attention except it come in through the 'margin' or 'fringe,' to use

James's expression; and more than this, that the apperceived idea cannot be acted upon until it is somehow worked over into a will-impulse. But we have found no introspective evidence that would support this. In the first place, action may take place, in which attention is not maximal, *i. e.*, in which the idea is not clearly apperceived; and in the second place, very many actions are performed without a conscious will-impulse after the apperception and before the movement. In short, one would believe Wundt's scheme to be logical rather than purely psychological. And of this, he seems to become partially aware in the Third Edition; and in order to make the theory conform more nearly to the new facts brought to light, he shrinks one, two, or all the processes up and crowds two or all of them together, and explains that there are cases of simple reaction (muscular, cerebral-reflex) in which we do not have the three steps clearly in consciousness. But it is difficult to see why he continues to cling to the formal analysis, and to talk in terms of perception, apperception and will-impulse, when one or more of them are not found at all.

In the sensorial reaction, the chance for the application of his scheme is much better. But, as was seen in the analysis, there is nothing to suggest this tri-parti division. What was actually experienced, was the direct recognition of the stimulus, by any one of three or four ways, after which the movement took place immediately. To be sure, the stimulus in this case must be attended to, and the greater the degree of attention it receives the more satisfactory the reaction. But the stimulus is not consciously worked up from the perceptive level to the apperceptive level. Attention is already present to a marked degree in preparation in the shape of expectation, and the stimulus is apperceived. Following at once upon this is the movement. It takes place immediately, without any conscious step corresponding to the will-impulse, for the muscular predisposition was already prepared in the beginning. So that in the muscular we have, first, a high degree of attention upon the movement to be made, perception of the stimulus, then movement. In the sensorial, we have high degree of attention upon the impression, apperception, then movement. In each case, the preparatory attentive state seems to be the essential thing upon which the other steps follow with pre-arranged certainty. Hence, the more closely we look into the reaction consciousness, the more strongly are we convinced of the truth of Külpe's contention that the preparatory stage is the most important one, and that Wundt's content theory is rather a logical one than strictly a psychological analysis.

In taking the simple reaction as the type of all voluntary action, we are keenly conscious that we are making an abstraction, and that in so far as it is abstract, it is so far from the reality of the ordinary voluntary action. And more than this, we are aware that the subdivision of the reaction into the four periods, is a further abstraction, and, hence, that we have prescribed conditions which probably never occur in ordinary action. But science has always to make abstractions, otherwise advancement is impossible: and it is only by such abstract and methodical means that we are able to ascertain the constituent mental processes in a given bit of experience, under given conditions. So the facts here given regarding consciousness under the given conditions, must surely be of significance for any theory of voluntary action that may be advanced; and, on the other hand, the theory must take account of the facts as here given.

## PART II

Every science has its own terminology, and the terms, though very often drawn from the general storehouse of words in ordinary usage, soon take on special meanings pertaining to the particular science. In other words, each science, in order to be exact, must employ terms that have a very limited, technical and definite meaning, that have in their own particular context a specific significance, quite different from the general loose meaning of everyday life. Psychology is no exception to this general rule. It uses a terminology quite its own, and the better the psychology, the more specific and technical are the terms it employs. This fact must be borne in mind in approaching the subject here under discussion. Unfortunately, many psychological terms have found their way into the science from philosophy, and the danger of confusion is doubly great in these instances. 'Voluntary action' is one of these terms which has come to psychology from philosophy, and is yet in common use in both. It also receives much discussion in ethics books, and because it includes movement, it also enters into biological and physiological discussions. Naturally, then, we may expect the term to be used loosely in psychology; and we may also expect a certain amount of philosophical confusion as to its meaning.

The concept 'voluntary action' in the technical sense, has found its place in all systems of psychology, and it will be worth our while to pass in review the criteria pertaining to the subject, as given by a few of the contemporary writers on psychology, and criticise the deliverances of one or two

of the latest. Titchener says,<sup>1</sup> "The word 'action' denotes both the mental condition and the mental concomitants of movement. Movement is, therefore, a more general term than action. All actions are, in part, movements, but only those movements which have conscious processes as their condition and other conscious processes as their concomitants can form part of action."

James maintains that in order to voluntary action, the mind must be supplied with images by which to guide the action, at the time it is executed.<sup>2</sup> "Whether or no there be anything else in the mind at the moment when we consciously will a certain act, a mental conception made up of memory images of these sensations defining which special act it is, must be there. . . . My first thesis, accordingly, is that there need be nothing else. And that in perfectly simple voluntary action there is nothing else in the mind but the kinæsthetic idea thus defined, of what the act is to be."

Höfdding says,<sup>3</sup> "Voluntary action proper is characterized, psychologically, by the idea of the end of action, and the means to its realization, and by a vivid feeling of the worth of that end. . . . A motor impulse presupposes the memory of executed movements; this may be either the memory of the appearance of the movement, or a motor idea proper. . . . This predisposition or internal preparation by means of which a movement is, as it were, adopted or fixed in consciousness, does not admit of more minute description. It is the fundamental element in the consciousness of an intended movement, and can be known only by direct introspection."

Sully's definition:<sup>4</sup> "A voluntary action is an action consciously directed to some end." "The fundamental element of will is desire."<sup>5</sup> His analysis of a simple case of voluntary action follows. "The process involved in the simplest type of voluntary action may be described as follows. The initial stage is the rise of some desire in the mind. This desire is accompanied by the representation of some movement (motor representation) which is recognized as subserving the realization of the object. The recognition of the causal relation of the action to the result involves a germ of belief in the attainability of the object of desire, or in the efficiency of the action. Finally, we have a carrying out of

<sup>1</sup> Titchener: *Outlines of Psychology*, 1899, p. 248.

<sup>2</sup> James: *Psychology*, II, p. 492.

<sup>3</sup> Höfdding: *Outlines of Psychology*, 1891, p. 318.

<sup>4</sup> Sully: *Outlines of Psychology*, 1885, p. 574.

<sup>5</sup> *Ibid.*, 575.

the action thus represented. This may be described as the direction of the active impulse involved in the state of desire into the definite channel of the action suggested. This last stage of the process of volition is known as the act. The desire which precedes and determines this is called its moving force, stimulus or motive. Since this motive involves the anticipation of the final realization, this consummation is spoken of as the object, purpose or end of the action, and correlatively, the action as the means of gaining or realizing the object of desire."<sup>1</sup>

Stout:<sup>2</sup> "Thus we may define a volition as a desire qualified and defined by the judgment that so far as in us lies, we shall bring about the attainment of the desired end because we desire it." "A voluntary decision is normally followed by action which carries or tends to carry it into effect."<sup>3</sup>

Ladd:<sup>4</sup> "By a volition we understand then, a definite conative activity consciously directed toward the realization of some mentally represented end, preceded or accompanied by the condition of desire, and usually accompanied or followed by a feeling of effort."

Lotze:<sup>5</sup> "An act is voluntary if the internal initiatory conditions from which an act springs are approved, adopted or controlled by the will, when they have taken place." "We can only speak correctly of will when the motives of various actions and their values are compared in full consciousness and the choice is made between them. It is quite unreasonable to assume that we express by the words 'I will' no more than is involved in the future tense 'I shall.'"<sup>6</sup>

Jodl: "The end-conscious act may be differentiated from the involuntary or blind action by being an act of will. Will is a narrow effort, a wider term; there is no will which is not effort, but not all effort deserves the name 'will,' because not all effort carries with it consciousness of what it is striving for."<sup>7</sup> Every voluntary movement is characterized by the fact that it is accompanied by an image of the movement to be executed; but the will itself cannot be left out of account."<sup>8</sup>

<sup>1</sup> *Ibid.*, 588.

<sup>2</sup> *Manual of Psychology*, 1899, p. 589.

<sup>3</sup> *Ibid.*, p. 599.

<sup>4</sup> *Outlines of Descriptive Psychology*, 1898, p. 356.

<sup>5</sup> *Outlines of Psychology*, Tr. by C. L. Herrick, p. 66.

<sup>6</sup> *Ibid.*, 119.

<sup>7</sup> *Lehrbuch: d. Psychologie*, II, p. 52.

<sup>8</sup> *Ibid.*, p. 61.



Ward:<sup>1</sup> "In ordinary voluntary movement, we have first of all an idea or representation of the movement, and, last of all, the movement itself." "Attention is the condition of action."

Many other psychologists define voluntary action in much the same way, for example: Dewey (*Psychology*, 1887, p. 359) defines it as, "Impulse consciously directed toward the attainment of a recognized end which is felt as desirable. It involves knowledge of the end, knowledge of the means to the accomplishment of the end. . . . An impulse must furnish the force; a desire, when chosen, becomes the motive."

Angell (*Psychology*, 1904, p. 341): "Such acts (voluntary) always involve foresight of some end. This end is desired or at least consented to, and certain muscular movements then occur, which are meant to attain the end."

Murray, in his *Hand Book of Psychology* (1887, p. 393), says: "Volitions are actions consciously directed to an end; and the problem of psychology is to explain the process by which we acquire control over our actions so as to make them subserve the end we have in view instead of being aimless."

So far, then, there seems to be pretty general agreement among psychologists, as to three essentials of action. (1) Action is movement consciously directed toward a desired end. The act itself is the means to the attainment of the desired end. (2) Some sort of imagery is the necessary condition or antecedent of the action: there must be memory images (visual or kinæsthetic) of a previous movement which accomplished the same end. (3) The 'impulse' furnishes the 'force' by which the movement is accomplished.

But in contrast to these utterances which are in general agreement, there are two or three recent writers who partially repudiate the commonly accepted doctrine. Thorndike, in the preface of his *Elements of Psychology* says, "In one particular the author abandons the accepted doctrine of the psychology books. That images of the resident and remote sensations produced by movement should be the usual excitant to the movement he cannot believe, and has never taught."<sup>2</sup> And in the text, his argument is as follows: first, with regard to the problem. "Psychologists have argued much about what kinds of mental states are the antecedents of movements in purposive action. The arguments concern chiefly (1) the so-called feelings of innervation, (2) the feeling of decision, of consent, of 'let this act be,' the fiat, and

<sup>1</sup> *Encyclopedia Britannica*, 9th ed. XX, p. 42.

<sup>2</sup> *Elements of Psychology*, 1905, p. 12.

(3) the memory images of the feelings produced by the movement."<sup>1</sup> The author follows James in making these images of two kinds,—images of 'resident' and 'remote' sensations. 'Resident' sensations are kinæsthetic sensations due to the movement; the 'remote' sensations are secondary sensations, sound, sight, pressure, etc., which accompany movement. He continues,<sup>2</sup> "Only recently has it been argued that, after all, there is no justification for the assumption that any peculiar sort of feeling is a necessary element of purposive action; that really any mental state whatever may be the antecedent of an intentional act. Yet this seems easily demonstrable. For instance, I just now completed the purposive action of writing, 'Yet this seems easily demonstrable.' The act was certain finger movements and certain eye movements involved in guiding them. But my antecedent state of mind contained no images whatever of feelings in my fingers, arms, or eyes, nor even sight of the words. It was simply the judgment, 'Yet this seems easily demonstrable,' felt with the auditory image of the words. A few hours ago I signed a lease and I can confidently affirm that the thought antecedent to the act contained no images of any sensations in any way connected with the act of writing my name, but only the auditory images, 'He came to my terms after all.' Professor James, who maintains that "whether or no there be anything else in the mind at the moment when we consciously will a certain act, a mental conception made up of these sensations (of the movement's results). . . must be there." (Principles, II, 402), gives illustrations which prove precisely that the antecedents to a movement need never have been its results. "We say, 'I must go down stairs,' and ere we know it we have risen, walked, and turned the handle of a door." (*Idem*, p. 579.) "Hallo! I must lie here no longer," is the antecedent to getting out of bed. In fact, the doctrine that the image of some one of the previous results or effects of the movement is its necessary antecedent in purposive action makes the perverseness of mistakes. The antecedent is some one of its previous preliminaries or causes. Occasionally, what was first a result or effect of a movement may later be thought of as a preliminary, and so become its antecedent in still later connections. But in general what has led to a movement, not what comes after it, will lead to it on future occasions. . . So, also, there is no need of restricting the word motive to any particular class of feelings. Any mental state may serve as a motive.

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<sup>1</sup> *Ibid.*, p. 281.

<sup>2</sup> *Ibid.*, p. 282.

For a motive to an act is simply any fact which assists to be present and to be approved a mental state which will have the act as its sequent."

The author does not pass criticism upon the first two of the problems which psychologists have argued about as he outlines them. He may, or may not accept the doctrine of the 'feeling of innervation' and the 'fiat.' The opinion of the present writer, however, is, that a consensus of opinion of the present day psychologists would show the innervation theory to be practically a dead issue. While the fiat concept would be more or less generally accepted, in the form of some doctrine of desire. The point of interest, as well as the point at issue in the present treatise, however, is with regard to the statement that "any mental state whatever may be the antecedent of an intentional action," and with the further statement that "controlled, purposive or voluntary action means, . . . behavior in which a purpose is felt, in what we think we are about, and act with foresight."<sup>1</sup>

To begin with, the author confuses the problem by assuming that 'purposive' and 'intended' acts are the same as 'voluntary' acts. As was pointed out at the beginning of this section, 'voluntary action' is one of the many technical terms of psychology, and as such, has a perfectly definite and restricted meaning, of which most psychologists are aware, as indicated by the list of definitions cited. But—witness the last quotation—Thorndike makes the terms 'purposive' and 'voluntary' synonymous. As a matter of fact, however 'purposive' is a very much wider and more general term than 'voluntary.' Assuredly, some purposive acts are voluntary, and most voluntary acts are purposive, but the terms are by no means synonymous. One might as well speak of any movement performed by the voluntary muscles, as psychologically voluntary; thus confusing biological purposiveness with psychological volition. A reflex is purposive, and so are many automatic actions, but no one claims that they are voluntary on this account. In like manner, the word 'intended' is not clear. It implies a higher degree of mentality than purposiveness, but here also, an act may perfectly well be intended and yet not be voluntary, as the term has been defined above. 'Intended' and 'voluntary' are certainly overlapping terms, as are 'purposive' and 'voluntary,' but they are by no means synonymous. So the author has been led astray in his treatment of action, by not having the problem definitely in mind. This is shown very clearly, by the class

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<sup>1</sup>*Op. cit.*, p. 277.

of illustrations he adduces to support his argument. To these illustrations, we will return presently.

But before taking up this point of special interest, let us briefly consider the paragraph headed, "The feelings produced by a movement rarely cause it." If we understand the author correctly, his argument in this section depends upon the assumption that most psychologists hold the 'resident' or 'remote' images to be essential to all action, which he himself calls 'purposive' 'intentional' or 'voluntary'; that the essence of the motive is these images. But the assumption is groundless. What they *do* hold, according to definition, and as instanced by illustration, is that these images when present, usually accompany or precede movements, as guides to them. In other words, in cases where the movements are not habitual, images tell which of an indefinite number of movements, is the appropriate one, which will most directly bring about the desired end. The individual has learned by past experience, that certain movements accomplish certain things, hence, when the idea of something to be accomplished comes to the mind, the idea of the appropriate movement as a means comes up with it as an antecedent to the movement, usually in the form of some sort of an image. Where this is not the case,—where ideas of movement seem distinctly not to be present, the action can hardly be termed voluntary, in the sense of the definitions, but rather a sensory—or ideo-motor, or even an automatic action, in which the details of execution are handed over to the nervous system, where movement follows directly, upon representation. As a matter of fact, the vast majority of our so-called acts in the course of the day, are of this class,—movements which just go off of themselves when the proper cue is received, whatever the cue may be. But the point which seems to have been left out of account by the author, when he says that "any mental state whatever may be the antecedent of an intentional act" is the fact that in most voluntary acts of the ordinary sort, the organism is predisposed toward a certain set of movements by way of habit.

A criticism of the illustrations, above mentioned, will help to make this clear. For example, he assumes that he has performed a voluntary act in the following: "I just now completed the purposive action of writing," "Yet this seems easily demonstrable." "The act was certain finger and arm movements," etc. No one will deny that this was a *purposive* act, but it was by no means voluntary, as the latter is commonly and technically understood; because the act was more than "certain finger and arm movements." It comprised the mental processes antecedent to and concomitant

with the movements involved in driving the pen. It involved the predisposition toward that kind of movement as well as the movements themselves; otherwise, the words might have been spoken, or any other inadequate action made. And this predisposition towards writing the words was a function of attention and was accomplished in the general preparation for the day's work. For the ordinary individual, it must also have involved various images, resident and remote, at the time of the preparation when he sat down at his desk. But whether they were present or not just before the writing of that particular sentence, or in the general preparation for the day's work, is immaterial. What is important, is the fact that most psychologists hold that memory images, resident and remote, were highly essential when the act of writing was being learned; *i. e.*, that in the genesis of the act, images were necessary as a guide to the act. The sort of act described in the illustration is very complex. It is one part of a system of related acts and cannot be isolated out of its surroundings and still retain its true relations; *i. e.*, it cannot be fully explained without recourse to its genesis. The same argument applies to the other illustration given, *viz.*, "A few hours ago, I signed a lease, and I can confidently affirm that the thought antecedent to the act contained no images of any sensation in any way connected with the writing of my name." But here again, the act is more than the writing of one's name. The desired end was a lease-signed-at-my-own-terms. The agent's coming to terms is the cue for certain predetermined hand movements, and the real act was the decision that the end should be chosen. The movements were predetermined in the general attentive state preparatory to the action. So by definition, only those purposive or intended acts which are voluntary, are held to have as an essential part of their motives, resident and remote images of previous movements. The writer of the illustration has made reactions similar to those instanced so many times that they are no longer purely voluntary acts, according to the general criteria of definitions given above, which, as we understand them, imply attention, not only to the end desired but also to the means of attainment. The acts instanced, like a host of ordinarily so-called voluntary acts approach the psycho-motor act in character. Titchener says (*Primer of Psychology*, 1905, p. 170), "So the impulse degenerates. In the first place, the idea of our own movement drops out of the motive. . . . The copy, the movement idea then disappears; it no longer means anything to the organism,—and an idea owes its life to meaning something. Secondly, the idea of the result becomes absorbed, so to speak, in the precep-

tion of the object. . . . The idea of result comes to be merely a sort of tag stuck on the perception." And it is to a class very like this psycho-motor action that the instances above quoted belong. For psycho-motor action and the (what may be termed) predetermined action, very nearly like it in character, are not voluntary action in the sense of the definitions. Neither the author's own illustrations, nor those quoted from James then, belong to that class of actions technically termed voluntary. They are purposive to a high degree, and are certainly intended, but they are not therefore voluntary.

So in the first place, the break which the author thinks he is making with the psychology books, in regard to the memory images, as constituents of motives to action, is neither consistent nor complete. It is inconsistent because the statement in the preface would indicate that he meant to predicate of all kinds of action the non-essentialness of memory images, while in the text, he leaves out of account altogether that which is technically termed 'voluntary' in the various systems of psychology. And his break is incomplete for the reason just mentioned; that his criticism does not take into account what is technically known as voluntary action.

There seems to be no reason why Thorndike should not subscribe to the general definition of action as consciously conditioned movement. But consciousness implies some degree of attention, and where there is attention, there must be something attended to. Hence, in all cases of action, something is being attended to, which is pertinent to the action; and it is difficult to conceive that this something-attended-to should be anything other than some sort of an idea of object to be acted on or idea of end, or result to be attained.

The present writer's own introspective analyses of simple voluntary acts point very decidedly to the necessary existence of quite definite ideas of end or result. For example, in the act of rising to open the door in response to a knock, the experience is as follows: At the sound of the knock, a startled feeling, the components of which seem to be upon analysis, a throb in the head, a pulsing flush over neck and face, one slower and stronger heart beat, followed by an increased rate, a catch of breath, and a slight depressing sensation about lungs. Almost simultaneously with the knock, visual images of the door, of the possible cause of the knock, *i. e.*, image of the hand and arm on the outside, with a more or less vague image of an individual come to consciousness. These images come simultaneously with the sensations just noted. After the knock has ceased, very frequently auditory images of it recur, as if it were continuing; visual images of a moving hand tapping the door usually accompany the

auditory. Simultaneously with these, or rather in rapid alternation with them, the idea, 'I must open the door and see who's there' arises. This comes as auditory word images accompanied actual movements of the larynx and back of tongue; and at the same time, relief from the depressing respiratory sensations. With the idea of opening the door, the movement toward it actually begins, and vague images of hand and arm at the handle arise. Meanwhile the attention is strongly expectant. Word images of 'who can it be,' 'have I expected any one' run through mind, and with them visual images of different individuals come and go; and this sort of interplay continues until the actual opening of the door puts a stop to it.

These introspective data would naturally be interpreted thus: The organic sensations indicate the feeling tone. The idea of opening the door to see who is there is most assuredly an idea of end or result. The visual and auditory images and the kinæsthetic sensations from throat are the constituents of expectant attention. The action is a reaction to an unexpected stimulus. Very few if any memory images of past movements are present because the means of accomplishing the desired end has no longer to be attended to. The reactor has previously been placed in similar positions an indefinite number of times, and his nervous system has learned by practice what the appropriate movements for this kind of situation are. In other words, it is what may be termed a predetermined voluntary action the condition of which is an antecedent idea of end, which idea of end necessarily involves attention.

Hence, we maintain, that if Thorndike means to include voluntary in its technical sense within 'intended' action, "any mental state whatever may" *not* "be the antecedent of" *all* "intended acts."

#### APPENDIX A

The method of questioning the observer in experimental tion of this sort, where introspection is difficult, is a valuable aid, and was made use of to advantage in this series of experiments. In the first place, it is valuable to the experimenter, because he may induce the observer to make his introspective records fuller and more complete. The experimenter, having read over the previous day's record, is aware of the deficiencies and gaps in the records, and can judge as to the thoroughness of the introspective picture. And by judicious questioning, he is able to bring out points of importance, that would, perhaps, not have been brought out

entirely spontaneously;—and all without danger of suggestion provided the questions are properly framed. The question should be so worded that it merely makes the observer aware that his introspection has not been as complete as desirable in regard to the point in question. In the second place, the method is valuable to the observer. A few wisely directed questions do much to add zest and interest, and may each be made to appear as a separate sub-problem to be solved. Which problems serve as something concrete upon which to work.

On the other hand, valuable as the method is, it is one which must be used with care, and one that cannot, with safety, be carried too far,—at the risk of invalidating the results.

*Cf.* Whipple, A. J. XII, 424.

F. Angell: *Meumann's Arch.*

#### APPENDIX B

Following is a classified list of introspections selected from the daily records. They are characteristic of the whole of the group, of which there is not space to include more. In each case the capital indicates the observer, the roman numeral the series; and the figure the reaction time.

Illustrations of the natural reaction are taken more freely from F and C than the others because neither of them had ever had any work in the reaction.

Similar lists of reaction introspections have been made by others. *Cf.* Titchener, *Manual*, Vol. I, Pt. II, pp. 220 ff. *Ach*, *Willensthatigkeit*; and *Benet*.

C. I. 40. "Attention divided between idea of stimulus and movement to be made. Feeling of unreadiness,—unpleasant. Strain sensations in neck, slightly in finger also. Hazy images."

F. I. 34. "Attention on sound of 'now,' then visualization of key; next to the coming stimulus, then back to my own person and key. Slight bodily strain, startled feeling at stimulus, followed by visual idea of key and of E. Confused."

F. I. 34. "Slight confusion, then expectant attention on E's key; Reaction followed stimulus without voluntary effort. Time short, slight relief."

C. I. 16. "Attention on reaction more fixed because of past failure. Muscular strain especially in muscle used to flex finger; singled it out after 'ready.' Strain in eyes and forehead."

C. II. 38. "General mood of 'must-try-harder.' Feeling



of insecurity as to results. Attention divided between stimulus and reaction. Clear images of bodily position and instrument."

F. II. .22. "Attention on 'now,' largely passive. No confusion. Stimulus was visualized. Conscious of downward movement of finger. Relief from strain."

Pn. II. .34. "Deliberate. Sound followed by visual image of its cause. Then remembered movement and pushed key."

C. II. .10. "Attention good, almost entirely on reaction. Clear image of self. Strain in forehead and finger; held breath from 'now' to movement. Reaction came with a jerk, giving relief. Reaction made before any image came."

## APPENDIX C

### *Preparation*

Wrong stimuli were sometimes used, mainly in order to bring out the nature of the reception of the stimulus.

The quotations here given are only typical of a great number of similar ones and are taken almost at random from the introspections collected.

Pn. I. .16. "At 'ready,' pulled myself together, bracing muscles, and held breath."

P. V. .14. "Visualization of surroundings; strained feeling in head and arm. Not only heard stimulus, but visualized its cause."

P. V. .18. "Visual image of movement before it was made."

M. V. .18. "Muscular tension all over; innervation of finger; auditory and visual images of stimulus; also kinæsthetic images in finger." She also remarks that "closing the eyes seems to shut out of consciousness many objects and associations, and makes it easier to narrow the attention to the experiment. The ear also ceases to hear disturbing noises and is intent on the coming stimulus, often imaging it. The finger is also keenly sensitive to its position and function."

Pn. IV. .12. "Visual image of swinging pendulum at coming of stimuli."

M. IV. .16. "Strain sensations in trunk; visual images of apparatus and table; auditory image of stimulus repeated three or four times."

M. II. .16. "Went through experiment mentally, in its steps, accompanied by visual, auditory, and kinaesthetic images. Saw table, experimenter, and apparatus; heard stimulus, and felt image of my movement."

C. I. .12. "Strain in head and finger; imaged instrument, also position of myself and experimenter."

C. III. .14. "Attention on finger, strain in finger, arm and head,—visual images. Stimulus came as surprise, and finger went off of itself, yet was conscious of its movement."

C. IV. .06. "Visual images of my movement, experimenter, and apparatus. Strain in forehead and finger with a tingling in the latter."

C. IV. .06. "Strain and tingling as before."

F. III. .12. "Strain with set or rigidity of muscles of shoulder and arm."

F. III. .10. "Visual image of experimenter's hand and stick, with tingling of arm muscles ready to act."

F. III. .12. "Strain in head with forward tendency of body. Visualization of instrument; a general explosive reaction which seemed to take place in shoulder and arm, and seemed of itself to move the key."

Pn. V. .10. "Muscular set, then attention to the coming stimulus."

Pn. IV. .12. "A holding back tendency to avoid previous error." (Reacting too soon.)

F. II. .14. "Strong inhibition to prevent release of key at 'now.'"

C. III. .14. "After 'now,' a tendency to react, but consciously inhibited."

### *Reception*

Pn. IV. .14. "Don't remember stimulus—attention on movement."

M. V. .14. "Barely perceived stimulus as sound,—just sufficient to set off movement."

F. II. .10. "Stimulus the cause for release, the reaction was the release."

Pn. III. W. S. "Reaction by kinæsthetic sensation. Realized afterwards that it was false stimulus by lack of jar."

Pn. V. .08. "Did not hear stimulus, but reacted to inclination to react to slightest provocation, and felt jar of stimulus."

Pn. V. W. S. "Knew that I reacted to W. S. by lack of jar and after-vibrations of stimulus."

Pn. V. (E snapped finger and released key.) "After reaction, a sense of unsatisfactoriness at stimulus, but why, I do not know. It seemed just like an echo."

Pn. V. .16. "Stimulus indistinctly remembered; came as natural course of events."

M. V. .12. "Stimulus not heard or attended to, seemed merely part of memory image."

Pn. V. (No stimulus given B.) "Reacted when tension reached climax and missed stimulus only after reaction was over."

### *The Movement*

F. II. .12. "The restraint caused by the preparation automatically removed; followed by relief."

F. II. .10. "At stimulus, a feeling of release; reaction constituted the release."

F. II. .12. "General explosive reaction; finger seemed of itself to move the key."

C. III. .14. "Great muscular relief came with stimulus."

C. IV. .15. "Finger seemed to release itself."

Pn. III. .12. "Auditory sensation and the feeling that I am releasing now while the sound of the stroke still vibrates."

Pn. III. Too Soon. "Muscular sensations at reaction, and pleasantness at belief of accomplishment of purpose."

Pn. IV. Too soon. "After 'now' an unpleasant muscular strain and suspense. With stimulus, a decided muscular relief which was pleasant." The relief, of course, is the result of the movement, but the observer evidently thought the action was a response to a stimulus, which was not the case, for the stimulus and movement were simultaneous.

Pn. V. Too soon. "Already at 'now' to react. Believe I should have done so whether the stimulus had come or not. Stimulus seemed long in coming, but it caused reaction almost before it came to consciousness." In this reaction the time relations are incorrect. The observer thought she reacted to the stimulus when in reality she reacted too soon. The most reasonable explanation, it seems to the author, is that the reaction was really made to the content part of the stimulus, *i. e.*, when the interval from the 'now' to the stimulus gets about so full (kinæsthetic sensations, breathing, etc.) the action goes off quite automatically as where it is in direct response to the auditory stimulus.

Pn. III. .10. "Stimulus and reaction seemed to coincide. Muscular sensations of reacting; felt key coming up."

C. IV. .12. "Response seemed identical with stimulus."

### *After-effects*

Pn. II. .08. "When stimulus came, a pleasant feeling of relief."

F. II. .12. "Instant relaxation of arm and shoulder. Pleasant."

C. III. .18. "Relaxation more pleasant because certain of having made better reaction."

C. V. .10. "Strong relief with reaction. Pleasant."

## APPENDIX D

*Preparation*

C. I. .28. "Attention went to a hasty reconstruction of the impression caused by previous stimuli as a pattern. When the stimulus came, there was an immediate comparison of the two, and after recognition, the movement came as a natural result of the preparation."

C. I. .28. "Waited a little after stimulus came to be sure it was right."

C. I. .28. "Strong tension about head in listening"

P. I. .28. "Was braced nervously and muscularly, to react to right stimulus."

P. I. .22. "Intent on having correct stimulus, and reaction seemed to be set off by *it*, as opposed to any other."

P. II. .28. "Tried to recall sound of previous stimulus."

P. II. .28. "An auditory image of stimulus, and at coming of stimulus a pleasant recognition of it as identical with image."

M. II. .24. "Imaged stimulus kinæsthetically, visually and slightly in throat."

M. III. .26. "Trying to ideate the sound exactly."

P. IV. .22. "Attention went to a hasty reconstruction of the stimulus, to be used as a pattern."

*Reception*

C. I. .28. "Stimulus identified easily."

C. I. .20. "Stimulus seemed to carry its own conviction to consciousness, where something seemed to hitch onto it, assuring its correctness."

P. V. .28. "Auditory memory of sound, and recognized stimulus as similar to it."

P. V. .28. "Recognized: in the sense that the auditory qualities of the sound fitted into the place they previously had, and still occupied in consciousness."

F. I. .26. "Tried to recall sound of stimulus. Did so partially by framing vocal reproduction on it. At stimulus, was conscious that sound was that for which I had framed vocal organs."

F. II. .22. "Failed to get any kind of picture of stimulus, grew confused and reacted unconsciously."

F. II. .24. "Recalled idea 'sharp' and 'chug,' and constructed and auditory pattern of it."

M. IV. .24. "Sound corresponded exactly to that ideated."

C. I. W. S. "Reaction not really caused by stimulus, but largely because everything was ready."

C. I. W. S. "Stimulus recognized as wrong, but finger pressed key without conscious volition, due to tension in that member."

M. III. .30. "Stimulus came in middle of two or three rehearsals of sound image, in wrong position in series, and made a hitch in experiment."

### *The Action*

F. "Usually, the recognition of the stimulus as the right one is followed by the consciousness that the arm is in motion."

M. II. .28. "Stimulus recognized as right, then felt my finger pressing key down."

### *The After-effects*

C. I. 28. "Strong relief about head, especially."

M. IV. .22. "Movement gave pleasant relief."















